able to be a mere case of mimicry between a cryptogam and a gymnosperm. Our authors, however, lay stress on the fact that there are two very distinct types of articulated root, belonging respectively to the two genera in question, but although Prof. Williamson recognises them both, he does not specially comment on the fact. As to matters of fact relating to the structure of the Calamodendron stem, opinion does not differ, but the Professor, as in the case of Sigillaria, views them as Cryptogams of exogenous growth, without, however, admitting the close relationship to the Equisetaceæ advocated by Mr. Carruthers.

The stems of Calamodendron were filled in solid with pith or cellular parenchyma when young, but became hollow with age, the fistular interior of the stem consisting then of a linear series of oblong chambers, making an entire internode and separated from each other by transverse medullary diaphragms. The exogenous zone consisted of numerous woody wedges separated from each other by peculiar prolongations of the pith, to which Prof. Williamson assigns the name of primary medullary rays, while secondary medullary rays separated the constituent vascular laminæ of each wedge as in recent Exogens. These extended vertically from node to node, when they underwent a change. The apex or inner face of each wedge originates in a duct or canal. Investing this woody zone was a thick cellular cortical layer without vessels. The bark is very rarely preserved and is not exogenous in character, the tripartite division of existing Coniferæ not being present. The outer surface appears to have been smooth, and not fluted longitudinally, at the same time masking the articulations. Camalodendron thus possessed exogenous wood playing exactly the same *rôle* as in Sigillaria, surrounding the pith, and closely resembling the first year's shoot of a recent conifer; but it differed in the verticellate arrangement of its appendicular organs. The structure of the root hardly differs from that of the stem, this indicating, according to the authors, a peculiarly primitive type, and the rootlets grew from the nodes and were branching. Prof. Williamson states, on the other hand, that the root is adventitious and not a prolongation of the main axis. The leaves or branchlets were distributed on the trunk at regular distances on the line of the nodes, which were pretty close together, alternating regularly from one to another, so that the appearance resulting was that of a quincuncial arrangement, the more obvious on account of the concealment of the nodes by the bark. There is no direct proof, but the authors believe that the foliage known as Archæocolamites and Bornia, consisting of repeatedly dichotomosing acicular leaves arranged in verticels around nodes on slightly striated stems, really belongs to Calamodendron, in which case the male inflorescence was born in catkins something like those of the Taxeæ. Sir J. Dawson, however, states that he has found leaves like those of Asterophyllites attached to stems of Calamodendron. The fruiting organs are still very imperfectly known, but Prof. Williamson believes them to have been a heterosporous Strobilus like those of Lepidodendron. The authors, in conclusion, remark upon the resemblance between leaves of Bornia and those of Trichopitys and Bryon, which are true Salisburieæ, for, though the one is verticellate and the other spiral in disposition, the possibility of an easy transition from one to the other is exemplified in Calamodendron, and both modes occur together in existing Cupressineæ and the young Abietineæ.

Prof. Williamson believes that Calamites and Camalodendron are one and the same plant, and this a cryptogam. Against the exogenous wood he sets the cryptogamic bark, the Strobilus with Calamite structure full of spores, the adventitious roots and the verticellate arrangement of the leaves. It seems hardly possible, however, that such observers as A. Brongniart, M. Grand'-Eury, M. Rénault, and our authors can all be mistaken. In the former volume a graphic description was given of the growth of the Equisetum-like Calamites as they occur at St. Etienne. Prof. Williamson has not come across an undoubted Calamite, and very prudently disbelieves in their existence, but his evidence seems negative rather than positive, and we have already seen in several instances that coal-plants may have flourished in great numbers in one country and yet be exceedingly rare in another. The Carboniferous lasted over an immense period of time, and there appears less reason, as their plants become more completely known, to suppose that the forests were then composed of few types universally distributed. Development was proceeding actively, and it is quite conceivable that a gigantic primæval Cryptogam might take on phanerogamous characters without greatly modifying its external appearance.

Another remarkable cryptogam with exogenous wood is described by Prof. Williamson as Astromyelon. The stem was hollow, and except that it was not articulated, resembled that of Camalodendron. It appears that the stem and branches grew together under exactly the same relation as those observable in an ordinary exogenous tree, the latter not differing materially in their outward appearance from those of an ordinary pine. He appears to have felt hesitation in classing it, as he uses the expression "I am inclined to place" it among Cryptogams. Its affinities he considers to be with Marsilea, and we have thus—perhaps—in the coal-measures arborescent representatives of the Lycopodiaceæ in Lepidodendron, of Equisetaceæ in Camalodendron, and of Marsiliaceæ in Astromyelon, all of them having possessed rudimentary exogenous trunks.

J. STARKIE GARDNER

HARBOURS AND DOCKS

Harbours and Docks. By L. F. Vernon-Harcourt, M.A. (Oxford: Clarendon Press, 1885.)

IN the author's previous work on "Rivers and Canals" the science of hydraulic engineering received a valuable addition and the subject was treated, as far as it was necessary for inland works, in a masterly manner, fully upholding the author's high standing in his profession. We have now another work by the same author, in which the sequel to "Rivers and Canals" is given. In "Harbours and Docks," sea-works and kindred engineering subjects receive full consideration, the two books containing together an excellent collection of data on hydraulic engineering generally.

Of all the many branches of the engineering profession, that of hydraulic engineering pertaining to sea works and similar constructions trusts less to theory and more by far to practice than any other. The hydraulic engineer for

sea works has no convenient formulæ to guide him, but only previous experience and precedent. This is evident from the volume before us, for most of the sea works described are improvements on previous constructions.

The author commences with a description of the natural laws which govern the general movements of the sea, the causes and action of its waves, tides, currents, and consequent changes in the coast line, the knowledge of which is all important when any new works are projected; indeed, it is not too much to say that many sea-works have proved very expensive in their maintenance owing to ignorance of the above conditions when they were designed.

The author divides the various types of harbours into five classes—(1) estuary harbours; (2) harbours with back-water; (3) harbours partly sheltered by nature; (4) harbours protected solely by break-waters; (5) peculiar types of harbours with detached break-waters. After having given long and clear descriptions, with excellent illustrations of the several types, the author remarks with reference to the first three classes and their shelter from the sea :—"Some natural shelter exists in all the harbours referred to above, but it will be noticed that the amount of shelter varies considerably. Thus whilst at Cherbourg, Plymouth, Wick, Genoa, and Barcelona the entrance alone of a complete bay requires protection; at Holyhead, Table Bay, and Alexandria only a portion of the extensive bays in which the harbours are situated can be utilised, though the existence of the bay diminishes considerably the exposure; and lastly, at Dover, Newhaven, and Colombo projecting points of the coast, rather than regular bays, are taken advantage of for the site of a harbour." After discussing the last two classes of harbours, we have the conditions which govern the size and position of the entrances to harbours explained. We commend these chapters to the careful perusal of those who take an interest in the proposed harbours of refuge, for here will be found considerable information concerning the advantages of the several sites proposed.

Chapter V., and those following, until the end of Part I. of the book is reached, deal with perhaps the most important of all sea-works—viz. break-waters. The author classifies their several modes of construction into three classes—(1) mound of rubble and concrete blocks; (2) mound with superstructure; (3) upright wall. Under these heads we find all the principal break-waters, each being well described, the construction explained, and reason given for any special work.

It is interesting to follow the gradual increased use of Portland cement concrete in the place of natural stone, and, as the latest break-water, we may take the one at Newhaven now in construction. This break-water is practically one solid mass of cement concrete. It is built on the upright wall system, with concrete in bags deposited from hopper barges on the chalk bottom up to low-water, and concrete-in-mass above. The bags each contain about 104 tons of concrete, the concrete being mixed by a special machine consisting of a screw working in an inclined cylinder, the materials being added at one end, water being added during the transit, thoroughly mixed concrete coming out at the other end.

In Part I. of the volume is to be found every information with regard to sea-works generally; the descriptions and details of the construction of the Manora break-water, Madras harbour, and Alderney break-water among the many others, are extremely interesting, being as well written as they are good. Of the American break-waters described, those constructed in the large lakes, are, as may be expected, principally constructed of wood, some being bound together by means of iron ties. The form taken is generally crib-work, floated out to the site in sections, and filled with stone. Before leaving the subject of break-waters we will quote the author's opinion on floating break-waters; this is interesting at the present time on account of the late experiments at Eastbourne and other places. He says :—"Various schemes have been suggested from time to time for arresting waves by means of floating break-waters moored in position. It has been imagined that the undulation being on the surface might be stopped or reduced considerably by an obstacle at or near the surface, and thus the cost of building up a break-water from the bottom could be saved; though, in the case of large waves, the undulatory motion is not simply superficial, yet, undoubtedly, the power of the waves would greatly diminish if the upper portions could be arrested in their progress; and the gain in dispensing with a solid structure founded on the bottom of the sea would be very great." He then tells us of several forms tried which were not successful in reducing the waves, and in conclusion says :—"The force of waves is so great, as indicated by its effects in moving huge masses, that no fragile floating moored construction could possibly oppose an adequate resistance. The accumulated power of the wind, acting through the medium of the waves, cannot be evaded, but must be met; and this can only be effectually accomplished by a solid break-water." This part of the book concludes with a chapter on lighthouses, beacons, and buoys; the construction and cost of all the important lighthouses is given and admirably illustrated.

In Part II. "docks" receive very full consideration, Chapters XIX. and XX. dealing with sites, preliminary works for docks and dock walls; suffice it to say that all these are treated in such a way as to render it evident that the author is thoroughly master of his subject. In Chapters XXI. and XXII. the usual fittings pertaining to docks are discussed, their entrances and locks, dock-gates and caissons of all kinds thoroughly described, and their varied construction under different conditions explained. All the following chapters, which occupy the last 150 pages of the book, are taken up with a general, and in some cases a detailed, description of some of the more important English and foreign docks; it is needless to say that they are all thoroughly well treated, and the trade statistics are carefully given and useful comparative distinctions drawn.

As a work on hydraulic engineering we can confidently recommend it to all those who are interested in the subject, feeling convinced that it will be found a most useful book. The author has produced, and students will profit by, a book well written, sound, and most useful in forwarding the science. Both volumes do credit to the publishers, the plates are good and well executed. These volumes ought to find a place in every technical library in the country.